February 10, 1898.

The LORD LISTER, F.R.C.S., D.C.L., President, in the Chair.

A List of the Presents received was laid on the table, and thanks ordered for them.

The following Papers were read :—

I. "Contributions to the Theory of Alternating Currents." By W. G. Rhodes, M.Sc. (Vict.). Communicated by Arthur Schuster, F.R.S.

II. "The Development and Morphology of the Vascular System in Mammals. I. The Posterior End of the Aorta and the Iliac Arteries." By Alfred H. Young, M.B., F.R.C.S., and Arthur Robinson, M.D. Communicated by Sir William Turner, F.R.S.

III. "Further Observations upon the Comparative Chemistry of the Suprarenal Capsules, with Remarks upon the Non-existence of Suprarenal Medulla in Teleostean Fishes." By B. Moore, M.A., Sharpey Scholar, University College, London, and Swale Vincent, M.B. (Lond.), British Medical Association Research Scholar. Communicated by Professor E. A. Schäfer, F.R.S.

IV. "The Effects of Extirpation of the Suprarenal Bodies of the Eel (*Anguilla anguilla*)." By Swale Vincent, M.B. (Lond.), British Medical Association Research Scholar. Communicated by Professor E. A. Schäfer, F.R.S.

"Contributions to the Theory of Alternating Currents." By W. G. Rhodes, M.Sc. (Vict.). Communicated by Arthur Schuster, F.R.S. Received January 4,—Read February 10, 1898.

(Abstract.)

This paper is divided into two parts. Part I deals with a method of finding the steady values of alternating currents in any circuits or systems of circuits, without having to perform integrations of differential equations which may be somewhat complicated.

It is assumed, however, that the electromotive forces and electric

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currents can be represented as simple sine (or cosine) functions of the time.

The method consists in applying the fact that if a simple harmonic function is differentiated twice in succession the result is proportional to the original function. By the application of this principle the determination of the steady values of the currents is reduced to solving a set of simultaneous *simple* equations.

After introducing the method by solving some simple problems, it is applied to the following :—

(*a*) The determination of the equivalent resistance R, reactance and impedance I, of a parallel circuit of n branches, taking into account mutual induction, when each branch may contain resistance, capacity, and self-induction.

The result is written

$$R = \frac{A_0C}{C^2+p^2B^2}, \quad L = \frac{A_0B}{C^2+p^2B^2}, \quad I = \frac{A_0}{\sqrt{C^2+p^2B^2}},$$

L being the equivalent self-induction, where A_0, C, B are certain functions of the resistances, self-inductions, capacities, and mutual inductions of the several circuits.

(*b*) The determination of the currents in the n circuits of an air core transformer having one primary coil and $n-1$ secondary coils.

In addition to solving the problem, the conditions for resonance in the primary circuit are obtained and discussed, and special attention is given to the case of a transformer having only one secondary coil.

(*c*) The determination of the outputs of n alternators working in parallel on a non-inductive external circuit.

PART II.

This part is devoted to the consideration of the effects of higher harmonics in E.M.F.s and currents on the values of the impedances and reactances of circuits.

The problems considered in Part I are again discussed on the assumption that the impressed potential difference is of the form

$$E = E_1 \sin(pt-\theta_1) + E_2 \sin(2pt-\theta_2) + \ldots + E_m \sin(mpt-\theta_m).$$

It is also shown that periodic E.M.F.s and corresponding currents can in all cases be represented by simple sine curves having the same root mean square values, and suitable phase positions depending on the time constants of the circuits and on the periodicities of the harmonics present.